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THE INFLUENCE OF MOBILE CHANNEL ON CUSTOMER BEHAVIOR IN OMNI-CHANNEL BANKING SERVICES

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Abstract

As mobile phones and tablets are in widespread use, the emergence of mobile channel is changing the way customers interact with financial institutions. In this research, we empirically examine how the use of mobile devices can improve customer informedness and affect customer behavior in financial transactions. We use a large-scale customer transaction data obtained from one of the largest commercial banks in the United States. Specifically, we investigate: (1) whether the use of mobile phones and tablets is associated with a higher level of customer informedness and demand for services; and (2) compared to customers that only transact through a PC, whether mobile phone and tablet users are less likely to incur overdraft and credit card penalty fees. This paper contributes new knowledge in omni-channel banking services by examining post-adoption customer behavioral changes using transaction-level observations. We also discuss insights for banks' managers related to the design of new mobile channel, and strategic management of existing digital and physical channels.

Keywords: Customer behavior, Customer informedness, Credit card, Late payment fee, Mobile channel, Overdraft fee, Over-limit fee.

1 Introduction

Advances in *information and communication technology* (ICT) have driven several waves of technology innovations in the financial services sector, and transformed the way customers interact with financial institutions (Kauffman et al. 2015a). Given the rapid adoption of smartphones and tablets and the widespread use of mobile apps, mobile devices become new tools that customer uses for financial transactions. *Mobile banking* involves a mobile device (e.g., smartphone, tablet, etc.) that is used for consumers to obtain financial account information and conduct transactions with financial institutions. According to Federal Reserve Board (2015), 87% of the U.S. adult population has a mobile phone and 71% of mobile phones are smartphone, while 39% of all mobile phone owners with a bank account have used mobile banking in 2014. As customers around the world are increasingly adopting mobile banking, banks are moving to embrace mobile channel for transaction migration, online interactivity, and payment solutions (Broeders and Khanna 2015). In the meantime, large banks are scaling back their physical channels by shrinking branch and ATM networks, and shifting to mobile banking. For example, Bank of America has steadily closed 10% branches and sliced out 2% ATMs over the past two years (Egan 2015).

The digitalization of banking products and processes has led to improvements on the efficiency and effectiveness of financial intermediation-related activities in the economy (Liu et al. 2015a). After the successful adoption and diffusion of ATM and Internet banking in the 1990s and 2000s, customers have been used to interact with banks' self-service channels at a lower transaction cost. The adoption of digital channels reduces banks' service costs, reallocates demand for services across multiple channels, and increases the customer profitability and loyalty (Xue et al. 2011). In the 2010s, most major banks have launched the mobile channel that provides several competitive advantages, such as good security, easy access, various apps for smartphones and tablets, and location-based services. Despite several advanced functionalities provided by mobile banking services, the customer's most common use of mobile channel is to check account balance and recent activities, and transfer money between an individual's own accounts (Federal Reserve Board 2015). One of main reasons for people who decided not to use mobile channel is their financial needs are largely met by banks' existing *self-service* channels (e.g., ATM and Internet banking) and *full-service* channels (e.g., branch and call center). Their concerns about the security of mobile devices and limited size of mobile phone screen also restrict the usefulness of mobile channel.

Thus, the influence of mobile channel on customer transaction behavior in an omni-channel context of banking services remains an unsettled empirical question. The widespread adoption of smartphones and tablets also provides a promising channel for customers to access their financial information. It allows customers to be the architects of what information they would like to receive and when they would like to receive (Corbat and Kirkland 2015). Customers, as a result, are increasingly informed about relevant services offerings and attributes, and exhibit different behaviors with greater *informedness* (Granados et al. 2012, Li et al. 2014). It is a competitive necessity for senior managers in banks to understand customer transaction behavior for better services design and delivery of more benefits and usefulness through mobile channel. We obtain a large-scale customer transaction data from one of the largest commercial bank in the United States to address the following research questions: what is the impact of mobile channel on customer transaction behavior in omni-channel banking services; and what are the customer behavioral changes in presence of greater informedness after the use of mobile devices?

We use customer transaction records through all digital channels, including transactions through a PC, a mobile phone, or a tablet, to examine the interrelationship between customer use of mobile channel and transactions related to demand deposit and credit card accounts. In particular, we investigate the consequence of the use of mobile devices on customer banking activities and transactions, including *online services demand*, *overdraft behavior*, and *credit card penalty fees*. We investigate: (1) whether the use of mobile channel is associated with higher customer online service demand and informedness; and (2) compared to the customers that only transact through a PC, whether mobile and tablet users are less likely to incur overdraft and credit card penalty fees. We apply propensity score match-

ing to construct control and treatment groups of customers with similar propensity for adopting a mobile device in order to reduce selection bias.

This study differs from and contributes to the research on mobile channel in banking services in two ways. First, we conduct this study in an omni-channel context of a large commercial bank in the United States, and link the use of mobile devices to different customer banking behaviors that have rarely been examined before (Hernando and Nieto 2007). The extant research on mobile banking has mostly been survey-based studies of the factors that influence customer adoption and usage, such as customers' intention to use, trust and risk perceptions, and service and bank attributes (e.g., Kim et al. 2009, Luo et al 2010, Zhou et al. 2010, and etc.). Without actual observations of customer transactions, it may introduce measurement error and limit the results to what are perceptible to customers (Xue et al. 2011). This paper overcomes the challenge of the lack of reliable and omni-channel transaction data to measure how the use of mobile channel affects customer transaction behavior and improves customer services.

Second, we explore how *customer informedness* influences payments for overdraft and credit card penalty fees in banking services. The reasons for investigating customer overdraft and credit card payment behavior are: (1) these fees count as important sources of revenues for banks. According to Moebs Services, customers paid fees of $32 billion on automatic overdraft loans in 2012 in the United States[1]; (2) customers only pay *limited attention* to their financial information due to high monitoring cost (Card et al. 2011), and their inattention to account balance, payment due date, or credit line may cause unfairly high financial charges for overdrawing their accounts, paying the minimum payment late, or exceeding their credit limit, respectively; (3) given the increased transaction activities following the adoption of mobile channel, the complete consideration of account status and higher level of informedness will better inform customer financial decision-making (Stango and Zinman 2014). By examining the causal link between the use of mobile channel and overdraft and credit card penalty fees, we are able to uncover the unobserved benefits that mobile channel brings along to customers. Prior research has mostly focused on the influences on customer profitability, loyalty, and cross-selling opportunities following the adoption of self-service channels from a firm's perspective (Campbell and Frei 2010, Xue et al. 2011).

2 Literature Review

We will review related literature on the impact of online channel adoption and customer behavior in presence of greater information.

2.1 Impact of online channel adoption

Prior research has explicitly examined the impact of online banking adoption on customer's channel usage and bank's financial performance. Hernando and Nieto (2007) argue that online banking acts as a complement to, rather than a substitute for, physical branches. Campbell and Frei (2010) find that customer adoption of online banking is associated with (1) substitution for more costly self-service channels (ATM and voice response unit); (2) *augmentation* of service consumption in full-service channels (branch and call center); (3) a substantial increase in total transaction volume; (4) an increase in estimated service cost; and (5) a decrease in short-term customer profitability. Geng et al. (2015) suggest that both bank branch opening and closure are associated with a decrease in customer transaction consumption through other physical channels, while an increase through online channels. Goh and Kauffman (2013) suggest that IT investments in online banking enhance bank's financial performance, and were made to complement firm strategy for both strategic advantage and necessity.

Hitt and Frei (2002) explore the difference on characteristic or behavior between customers who use electronic delivery channels and those who use conventional channels, and find that online banking users tend to use more products and are more profitable. Xue et al. (2007) further consider the channel

[1] http://www.moebs.com

[2] Definitions are available at CreditCards.com: http://www.creditcards.com/glossary/term-overlimit-fee.php and

usage and find that higher customer efficiency in self-service channels is associated with greater profitability and has a complex relationship with customer retention and product utilization. Xue et al. (2011) study the determinants and outcomes of Internet banking adoption, and find that customers who have greater service demand and higher efficiency, and live in areas with a greater density of online banking adopter, are faster to adopt online banking. They also find that customers increase their banking activities, acquire more products, and conduct more transactions in the post-adoption stage. Our work continues in the same vein of analyzing customer transaction data to measure the actual use of mobile channel in banking services.

There is an emerging stream of research that has examined the impact of mobile channel introduction on the existing online channels in e-commerce. Ghose et al. (2013) quantify the economic impact of tablet introduction on sales volume and revenues in e-commerce, and their results suggest that tablet channel acts as a substitute for the PC channel and a complement for the smartphone channel. Bang et al. (2013) find that the performance impact of mobile channel introduction depends critically on product characteristics and the fit between a channel and a product. The extant literature on banking services primarily focuses on the interdependence between different channels, and examined the *substitution* and *complementarity* between online and offline channels. However, our work examines the impact of the use of mobile channel on customer transaction consumption in the scope of all available digital channels in retail banking.

2.2 Customer informedness and banking behavior

ICT enables electronic service delivery channels for financial services and provides greater *information availability* (Li et al. 2014). After mobile banking adoption, customers may change their behavior in presence of lower searching costs (Bakos 1997) and higher information availability (Clemons 2008). Prior research suggests that *limited attention* hinders individuals from acquiring and using all available information for financial decision-making (e.g., DellaVigna 2009, Hirshleifer et al. 2009, Hong and Stein 1999, and etc.). Stango and Zinman (2014) show that fee-paying is affected by shocks to attention that contain no information about recent behavior or the structure of fees for a particular person. Karlan et al. (2010) suggest that informative reminders may increase savings in deposit accounts and be more effective when they increase the salience of a specific expenditure. It is instrumental for us to understand how the increased customer informedness following mobile channel adoption affects their fee-paying behaviors.

There is a dearth of empirical research that has explained the incentives for customers' overdraft and cause of credit card late payment and over-limit penalty charges (Agarwal et al. 2008, Liu et al. 2015b). Stango and Zinman (2014) summarize that full-information rational decision-making and limited attention can explain customer overdraft behavior. Liu et al. (2015b) suggest that mobile alert mechanism may help customers to eliminate balance perception error and prevent overdraft fee, and thus reduce customer attrition. Agarwal et al. (2008) study the credit card cash advance, late payment, and over-limit fees, and find that consumer learning from paying a fee is effective in avoidance of triggering future fees. A related study by Stango and Zinman (2009) suggests that customer who use different cards at the point of sale and repay credit card debt with available checking balance can largely avoid over-limit and late payment fees.

3 Hypotheses Development

We next develop our hypotheses related to service demand, customer informedness, and overdraft and credit card penalty fees. We conceptualize our hypotheses in Figure 1.

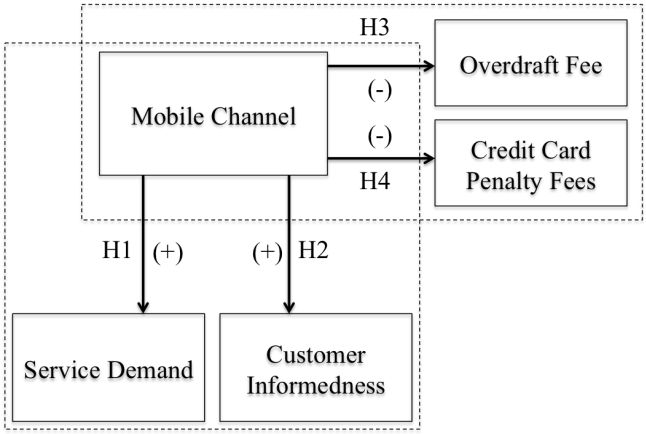

Figure 1. Conceptual model of mobile channel usage.

3.1 Service demand

The digital channels in banking services enable customers to access account information, transfer money between different accounts, and make payments through PCs and mobile devices. Transactions made through mobile phones, tablets, and PCs are all digital banking transactions. An important thread of related literature has been using customer account, transaction, demographic, profitability, retention, and channel density information to investigate the drivers and outcomes of Internet banking adoption (Campbell and Frei 2010, Xue et al. 2011), and found that Internet banking adoption has a substantial positive *volume* effect for the adopters. Ghose et al. (2013) show that the introduction of tablets can enhance the sales volume and shares in e-commerce, and customers tend to transact more when a tablet is used with a PC, a smartphone, or both. Provided with the wide adoption of mobile devices and ubiquity of mobile network, customers can access to their bank account using mobile phones or tablets anytime and anywhere, and thus we suggest:

- **Hypothesis 1. (H1) (Volume Effect of Mobile Channel).** *The use of mobile channel is associated with higher transaction volume through all digital channels.*

3.2 Customer informedness

Most modern banks have launched mobile apps and mobile alerts to allow for increased information monitoring and active account management (Campbell and Frei 2010). Mobile banking provides a new channel for customers to access to detailed information about their accounts, and improve *customer informedness* (Granados et al. 2012, Li et al. 2014). It facilitates more inquiry transactions through digital channels about account balance, monthly statements, financial charges, payment overdue alerts, and available credit line. We measure the degree to which customers know about their financial status using the number of monthly inquiry transactions as a proxy variable. Given the lower transaction cost to become informed after mobile channel adoption, we examine the following:

- **Hypothesis 2. (H2) (Mobile Channel and Customer Informedness).** *The use of mobile channel is associated with greater customer informedness.*

3.3 Overdraft and credit card penalty fees

Smaller banks are heavily reliant on overdraft and credit card penalty fees to make profits. They face the challenges on how to mitigate customer dissatisfaction and outrage, while maintaining important sources of revenue. In the United States, an overdraft occurs when money is withdrawn from a bank account by check, by ATM, or by debit card at the point-of-sale, resulting in the available balance goes below zero. Two main reasons for customer overdraft are intentional short-term loan, and inaccurate account register or overspending through negligence. Liu et al. (2015b) argued that customers who are uncertain about the exact balance amount might inattentively overdraw their account. Therefore, given the greater information availability following mobile channel adoption, we expect:

- **Hypothesis 3. (H3) (Mobile Channel and Overdraft Frequency).** *The use of mobile phones and tablets is associated with a decrease in a customer's overdraw frequency.*

Informed customers may change their banking behavior following mobile adoption, so we expect that the use of mobile channel will reduce the number of a customer's credit card over-limit and late payment charges. An *over-limit fee* is charged when customers' monthly credit card balance goes over their line of credit, and a *late payment fee* is charged to a cardholder who misses paying at least their minimum payment by the payment deadline.[2] Thus, we assert the following:

- **Hypothesis 4A. (H4A) (Mobile Channel and Over-Limit Charge).** *The use of mobile channel is associated with a decrease in a customer's over-limit charges.*
- **Hypothesis 4B. (H4B) (Mobile Channel and Late Payment Charge).** *The use of mobile channel is associated with a decrease in a customer's late payment charges.*

4 Research Site

We next provide an overview of our research site and propensity score matching method.

4.1 Research site

We acquired access to a large-scale anonymized data of individual-level transactions from a major retail bank in the United States.[3] The bank serves millions of customers in more than 20 states through thousands of branches and ATMs, as well as electronic service delivery channels, including telephone banking, Internet banking, and mobile banking. It provides a variety of banking products and services to meet customer financial needs, and is among the first of financial institutions that have invested in Internet banking and mobile banking innovations. The bank launched mobile banking and personal financial management mobile apps around 2010 in Apple and Google app stores to assist customer with smarter money spending and avoiding unnecessary fees. The bank's strategic objective of mobile channel is to improve customer services and engagement, and reduce churns for low income and under-banked segments. Table 1 provides definitions of the variables in our analyses.

Variable	Definition
Transaction Number	Total number of monthly transactions through mobile phones, tablets and PCs
Mobile	1 if a mobile phone is used for transaction in a month, 0 otherwise
Tablet	1 if a tablet is used for transaction in a month, 0 otherwise
INQ Number	Number of monthly inquiry transactions
XFR Number	Number of monthly external transfer transactions
SER Number	Number of monthly service transactions
MAI Number	Number of monthly maintenance transactions
Current Balance	The balance in deposit account at the end of month (in thousands)
Average Balance	The average balance in deposit account in the last 12 months (in thousands)
Average Transaction Number	The average number of online transactions since the customer is on file
Age	Age of primary account holder
Tenure	Number of years since the customer is on file
Low Income	Identifier of low-income customer
Branch Density	Number of branches in a zip code
ATM Density	Number of ATMs in a zip code
Overdraw Frequency	Number of overdraw transactions in a month
Over-Limit Charge	Number of over-limit charges in a month
Late Payment Charge	Number of late payment charges in a month

Table 1. Variable definition.

[2] Definitions are available at CreditCards.com: http://www.creditcards.com/glossary/term-overlimit-fee.php and http://www.creditcards.com/glossary/term-late-payment-fee.php.

[3] The identity of the bank is anonymized due to non-disclosure agreement.

4.2 Propensity score matching

We treat the use of a mobile device as the treatment that the customers receive, and assume customers' decision to adopt mobile channel is based on their endogenous characteristics, such as age, tenure, income level, availability of alternative channels, and banking behavior. However, the mobile banking adopters may inherently be more prone to use mobile devices for banking, or have higher transaction demand through digital channels. Thus, when we compare the difference in service demand and other behaviors between adopters and non-adopters, the self-selection problem of adopters may result in biased estimates of the impact of mobile channel adoption. To control for the potential selection bias, we use propensity score matching method to select a pair of treated and untreated customers with similar probability of receiving a treatment based on their individual characteristics.

5 Research Methodology

We use a sample of matched customers observed over a 3-month period to test H1-H3, and another sample of credit card customers to test H4A and H4B.

5.1 Service demand and customer informedness

To test H1 and H2, we estimate the impact of the use of a mobile phone or a tablet on the number of a customer's total and inquiry transactions in the digital channels. We include the counts of bank branches and ATMs within the same zip code of the customer's primary residence to control for the availability of physical channels. There are two key issues in the econometric specification: (1) the number of transactions for a given customer in a month is discrete and over-dispersed; and (2) the unobservable heterogeneity across customers, such as different demographic characteristics and capabilities for accessing to mobile technology, needs to be controlled for (Campbell and Frei 2010).

We use a random-effects negative binominal model to deal with count data with over-dispersion. We assume individual customer differs randomly in a manner that is not fully accounted for by observed covariates. The probability of observing y_{it} total or inquiry transactions for customer i at month t is modeled as:

$$E(y_{it}) = \exp(\beta_0 + \beta_1 Mobile_{it} + \beta_2 Tablet_{it} + \beta_3 Mobile_{it} \times Tablet_{it} + \beta_4 Branch\ Density_{it} + \beta_5 ATM\ Density_{it} + \phi X_{it} + \delta_i),$$

where δ_i is the customer-specific random effect and X_{it} is a vector of time-varying control variables, including the balance in the deposit account at the end of each month (*Current Balance*), number of different types of transaction per month (*XFR Number*, *SER Number*, *MAI Number*), and binary variables that indicate whether a certain type of transaction has been made within a month (*XFR*, *SER*, *MAI*). The coefficients β_1 to β_3 will capture the volume effect of the use of mobile phone or tablet on the service demand in digital channels.

5.2 Customer overdraft and credit card penalty fees

We apply zero-inflated negative binominal model to test H3 and H4, since the dependent variables, *Overdraw Frequency*, *Late Payment Charge*, and *Over-Limit Charge*, display excess zeros in addition to over-dispersion. Two possible processes generate the zero-inflated observations. For a given customer i, one process of generating only zero counts is chosen with probability of φ_i, while the other process generates counts from a negative binominal model with probability $1 - \varphi_i$. The probability φ_i depends on the characteristics of customer i, which are a vector of time-invariant zero-inflated covariates z_i, including *Age*, *Tenure*, *Low Income*, *Average Transaction Number*, *Average Balance*, enrollment of overdraw protection (*Overdraw Protection*), number of credit cards that the customer has (*Number of Cards*), *Credit Line*, and average monthly spending level (*Average Statement Balance* / *Credit Line*). We test H3 and H4A and H4B using the following specifications for the process that generates data from a negative binominal model:

$E(Overdraw\ Frequency_{it}) = \lambda_{it}(1-\varphi_i) = \exp(\beta_0 + \beta_1 Mobile_{it} + \beta_2 Tablet_{it} + \beta_3 Mobile_{it} \times Tablet_{it} + \beta_4 Branch\ Density_{it} + \beta_5 ATM\ Density_{it} + \beta_6 Current\ Balance_{it} + \beta_7 Transction\ Number_{it} + \phi z_i)(1-\varphi_i)$;

$E(Over\ Limit\ Charge_{it}) = \lambda_{it}(1-\varphi_i) = \exp(\beta_0 + \beta_1 Mobile_{it} + \beta_2 Tablet_{it} + \beta_3 Mobile_{it} \times Tablet_{it} + \beta_4 Last\ Statement\ Balance_{it} + \beta_5\ Last\ Statement\ Balance_{it}/Credit\ Line_{it} + \beta_6 Last\ Statement\ Min\ Payment_{it} + \beta_7 Number\ of\ Cards_{it} + \phi z_i)(1-\varphi_i)$;

$E(Late\ Payment\ Charge_{it}) = \lambda_{it}(1-\varphi_i) = \exp(\beta_0 + \beta_1 Mobile_{it} + \beta_2 Tablet_{it} + \beta_3 Mobile_{it} \times Tablet_{it} + \beta_4 Last\ Statement\ Balance_{it} + \beta_5\ Last\ Statement\ Balance_{it}/Credit\ Line_{it} + \beta_6 Number\ of\ Cards + \phi z_i)(1-\varphi_i)$.

6 Research-in-Progress and Discussion

We have developed some preliminary research results on the influence of mobile channel that are subject to a non-disclosure agreement review process. We are not able to report them until we obtain the corporate sponsor's sign-off and permission for reporting them. To date, we have completed the following analysis work: (1) estimation of the models that we have described above; (2) preliminary results on the hypotheses that we have tested, and some of which tested out as we expected them to, and others for which the hypotheses were not supported; and (3) adjusted models and deeper assessment of data issues so that the research produces cleaner findings, as the primary basis for the scientific results of the research. We also (4) are currently further exploring the extent to which customer learning from first occurrence of overdraft and credit card penalty fees may influence our results and either strengthen or weaken some elements of them.

As customer behavioral patterns are away from physical channels toward digital channels (Egan 2015), major commercial banks are engaging the customers that are active through mobile channel to address their growing financial needs. Mobile customers are exposed to cross-channel, targeted, just-in-time product or service information in an effective and seamless way (van Bommel and Edelman 2015). The rapid shift toward online and mobile banking might suggest the demise of the branch and ATM channels, and banks might be able to shrink the network size to slash costs. However, in the digital age, customers are using multiple channels, rather than turning solely to online or branch services. Branches still play an important role in taking customers from physical to digital channel. Compliance to regulation, demand for personal advice, and concerns about online banking security continue to drive the need for branch services (Barquin and HV 2015). On the other hand, there are significant costs to create and maintain ATMs, and the surcharges for non-customer usage are becoming increasingly expensive and difficult. It is expected to see ATM is another area where banks, as an industry, can cut costs. In the meantime, banks may strategically turn the ATM into a marketing vehicle for advertising, customization, cross-selling opportunity, customer data collection, and brand reinforcement. Customers' *limited attention* and high *monitoring cost* for acquiring all the available information cause the charges of overdraft and credit card penalty fees. The investigation on mobile channel adoption and customer informedness will deliver significant managerial implications for bank's offering of liquidity management services, implementation of mobile alerts system, and redesign of fee structure, in order to increase customer satisfaction (Kauffman et al. 2015b).

In this research, we explore the influence of mobile channel on customer transaction demand across multiple digital channels, and customer behavioral changes related to their demand deposit account and credit card account. In an omni-channel context of banking services, our results will deliver implications for banks' strategic distribution of physical ATMs and branches and channel management between online and offline banking. To the best of our knowledge, our work contributes the first study of mobile banking to examine customer post-adoption behavioral changes using actual observations of customer transaction. We conduct quantitative research on how the use of mobile devices affects customer's financial decision-making. Overdraft and credit card penalty fees are important sources of revenue in retail banking, while may cause customer attrition and induce potential tighter regulation. This research will be able to deliver important implications to senior managers in banks and policy-makers for consumer protection and financial services supervision and regulation. With the aid of *big*

data generated from customer transactions and financial management activities, banks can understand customers' usage pattern in the omni-channel context and financial decision-making process. Banks are able to target the consumer segments that are more profitable and loyal, and help them to be informed for making better financial decision.

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